Art. I.—*On the Growth and Habits of Biporae.*

By C. M. MAPLESTONE.

(With Plate I., Figs. 1 and 2).

[Read 10th March, 1910.]

In the collection of Polyzoa, dredged by H.M.C.S. "Miner" from a depth of 80 fathoms, about 22 miles outside Sydney Heads, which was submitted to me by Professor Haswell for examination and report, the most interesting were some conical forms of *Biporae*, of which three were new species, and a scrutiny of them shewed that they, in common with previously known species, differed considerably from other polyzoa in many points, especially in the arrangement of the individual zooecia composing a zoarium, their method of growth and the attitude of the zoaria when living.

My observations, however, point to very different conclusions from those expressed in a paper by Mr. Whitelegge in the Pr.L.S. N. S. Wales, 1887, page 387, et seq.; in which he established the genus *Bipora*, and included in it the following species:—*Lunulites philippinensis*, Busk; *L. cancellata*, Busk; *L. angulopora*, Ten. Woods; *L. incisa*, Hincks; *Cupularia crassa*, Ten. Woods; *Conescharellina depressa*, Haswell; *C. conica*, Haswell; *Eschara umbonata*, Haswell; and *Flabellopora elegans*, D'Orbigny; they being, he says, "a most distinct group having little in common with those with which they have been associated except habit and form." This last statement I must question, because as to their "habit" it will be seen from what follows that it is far from being known or understood, and as to their "form," the forms not only of the zoaria but also of the zooecia are so very different that I do not think they can possibly be assigned to any one genus, and the inclusion of them under the name of *Bipora* only adds to the perplexity that already exists in respect to them; I am not at present in a position to discuss this portion of the subject with certitude, but on a future occasion I may be able to offer a more

satisfactory classification of the species abovenamed, and the new ones described in my report upon the "Miner" polyzoa.[1]

After remarking that the structural features presented by the various species of this group are of such an exceptional character that it will be necessary to remove them altogether from the family *Selenariidae*, in which most of them have been placed, and that they appear to possess characters which are either unknown or rarely found in other species of Polyzoa, Mr. Whitelegge states that the "method of growth (not habit or form) or increase in size of the zoarium by the addition of new zooecia is intercalary, taking place on the surface between the cells already formed and not at the outer margin, as in most other polyzoa."

This view, I think, is incorrect. Intercalary zooecia could not cause any *increase in size* of the zoarium. There is a certain organic connection between all parts of a zoarium, but it is not such as would cause the zoarium to swell in size if new zooecia were intercalated among the others. From my examination of the various species I find increase in size is made on the margin of the flat, or nearly flat, species; consequently, as in all other disk-like forms, the zoaria grow from the centre to the circumference.

The conical *Biporae* grow from the apex to the base; I do not say downwards because I believe that, when living, the base is uppermost. A proof of the correctness of this opinion is shown in those zoaria which have the coral *Dunocyathus parasiticus* growing on, or out of, their bases; for it is impossible that they could rest upon them, because the delicate tentacles of the coral would be crushed, and the coral could not live under such circumstances. Among the *Biporae* dredged by H.M.C.S. "Miner" were a few with this coral growing on them, and through the kindness of Professor Spencer I have received some specimens of *Biporae*, dredged some 104 fathoms off the coast of South Australia by Dr. Verco, of Adelaide, in which the coral is imbedded in the zoaria, and also some sections of the same. The sections show the base of the coral to be sometimes far down in the zoaria, and that the zooecia formed subsequent to the commencement of the growth of the coral have grown up

1 Records of the Australian Museum, Sydney, vol. vii., No. 4, 1909, p. 267, et seq.

round the outside of it. Fig. 1 is a sketch made under the camera lucida of a section; it, however, is somewhat imperfect owing to the very brittle nature of the coral, but it will be seen that the coral started to grow upon the *Bipora* at a very early stage of the latter's existence. I have indicated the junction of the coral and the *Bipora* by a thick line. A characteristic pointing to the same conclusion is that in these conical forms the zooecia are, in almost every instance, in perfectly regular rows from the apex to the base, they very gradually increase in size from the apex to the base, and the zoaria preserve their shape throughout their growth—i.e., both the young and the old zoaria have the same angle at the apex.

As stated above, I consider the conical forms in their living state have the base uppermost. This would seem to be incredible, but in a postscript to his paper Mr. Whitelegge mentions he had had the good fortune to have had a living specimen of *Bipora philippinensis* (a nearly flat form living in Port Jackson) under observation for three days; and that from it there extended fine filaments, half an inch long, attached in some cases to tubes of Annelids and fragments of shell. He says the filaments appeared to grow out of an avicularium. This affords a clue to the manner in which the conical forms manage to live with their bases upwards. All of them have on the apex small avicularia and pores, and I consider that from these pores filaments similar to those recorded on *Bipora philippinensis* grow, and probably attach themselves to fragments of shells, etc., on the surface of the ocean bed, and so anchor themselves. Professor Harmer, in his Presidential address to section D. of the British Association for the Advancement of Science at Dublin, in 1908, stated he had some evidence that Selenariidae (in which the Biporae were originally placed) may be attached to ooze by means of very delicate, flexible rooting processes, and he has suggested to me that probably these conical forms are attached by a ligament to some foreign substance in the same way as *Parmularia obliqua*, McG., is, and that they hang downwards in the water. This is possibly the case, but the ligaments may be strong enough to permit the zoaria being sustained in an upright position, or in any position between the vertical and horizontal.

Mr. Whitelegge further states that most of the published figures of the zooecia are upside down. This is accounted for by the extraordinary circumstance that the zooecia are really upside down; indeed, he admits as much when he says "the direction of the zooecia is also apparently reversed," and he says that the free distal edge of the operculum is directed towards the apex of a conical form. The free edge of the operculum is directed towards the apex, but it is not the distal edge. The fact is that the operculum is hinged at the distal edge, and not at the proximal one; so that in these conical forms not only are the zooecia upside down, but the operculum is also upside down and in the specimens, in which the operculum is not preserved (both fossil and recent) the sinus is always in the distal margin of thyrostome and not the proximal one, as in other polyzoa of the family *Schizoporellidae* (in which Dr. MacGillivray placed the Biporae). To make clear what I mean by saying the zooecia are upside down, take the case of the other cheilostomes; the zooecia are formed one beyond, or above another, and the later formed ones rest upon, or are joined to the earlier formed ones with the proximal end resting upon or joined to the distal end of the preceding zooecium, and the thyrostome is situated in the distal portion of the zooecium with the operculum hinged at the proximal margin opening downwards. Now in the conical *Biporae* the zooecia follow one another in a somewhat similar manner, but the zooecia are in a reversed position: that is, what is the proximal, or lower wall in the ordinary cheilostomes, is in them the distal or uppermost, the thyrostome is in the proximal portion of the zooecium, and the operculum is hinged at the distal margin of the thyrostome opening upwards. The cause of this peculiar reversal of the ordinary arrangement is unknown, but Professor Harmer points out to me that it would seem to show "that the polypide bud while in a young condition might get twisted round 180 degrees in the zooecium." This probably is the case, but, before twisting round, the polypide bud must have in its growth extended itself to the end of the zooecium furthest from the older zooecia before turning round and developing into a mature form. Absolute proof of this cannot be determined until some spirit preserved specimens of living forms be

obtained, and that is a matter of some difficulty, because these conical forms are only found at depths of from 80 to 250 fathoms, and are so small that when dredged up that they might not be discovered in time to properly preserve them.

Another structure in these *Biporae* which has puzzled me, and also Professor Harmer, is the "semi-lunar slit" which Mr. Whitelegge considers to be the commencement of a new zooecium. He gives a very circumstantial account of it and its development into zooecia, but I have not been able to discover any instances of such development in any of the specimens I have examined. This "slit" he reports as being seen in all stages of its development in *Bipora philippinensis*, but in a slide which he sent me some years ago containing some 40 specimens of that species I could only find it on two small highly calcified fragments; though subsequently on a slide, lent me by the Curator of the Australian Museum since I examined the "Miner" polyzoa, there were several specimens of this species, in most of which the semi-lunar slit was present in what I take to be the perfect or complete state. (See Fig. 2.) I could not find in any of them an imperfect or younger form. These slits surround a nearly circular flap, the base of which is connected with the surface of the zoarium by a raised nodular process, and I consider it is improbable that such as are present in the specimens could eventually be continued, so as to complete the circle, through this thickened process, and cause the flap to fall off, and even if they did, the opening would not correspond in either size or shape with the ordinary peristomial orifice; and if, as Mr. Whitelegge states, there were underneath this external orifice an oral opening, it would indicate the formation of a zooecium considerably below the surface of the zoarium, in no way contributing to its "growth in size." Now if the theory that the semi-lunar slit is always the commencement of new zooecium be correct, it should be found in all the various species of *Biporae*. Mr. Whitelegge records it in *B. angulopora* and in *B. elegans* (in addition to *B. philippinensis* already alluded to), and states that it is *not* seen in any specimen of *B. umbonata*, in the Australian Museum, which is the species in respect of which he states Professor Haswell's description of the "different forms of the mouth" showed

the various stages of it; and also it is the species in which he says he saw the oral aperture underneath the peristome, which caused him to determine the name of the genus, for the reason that he considered the slit itself when completed forms the *peristomial* orifice, and as it is formed *before* the oral aperture, he assumed it to be therefore the *primary* orifice and the oral aperture the *secondary* one; and the occurrence of the *two* orifices caused him to name the genus BI-*pora*. It is important to note that he makes no mention of the occurrence of the slit in his descriptions of the other species dealt with in his paper. With regard to these "slits" I must confess that my reasoning depends a great deal upon what I may call negative evidence. It is to be regretted that Mr. Whitelegge did not illustrate his paper with figures, showing the various stages of development of which he speaks; so that it is extremely difficult to deal satisfactorily with the subject, and these "slits" must at present remain an unsolved enigma.

Another point of interest in connection with the *Biporae* is that up to the time of the publication of Mr. Whitelegge's paper there was no record of any ooecia having been seen upon any species of this genus. In his description of *B. philippinensis* he states that they are present in that species, and his description of them is, "external, globose, smooth, with a faint fimbriated stigma in front"; but he gives no figure. Many, if not all, of the specimens of this species which are upon the slide lent to me by the Curator of the Australian Museum, had ooecia upon them, and as I had not seen them before, I made a drawing of a portion of one zoarium, which is here reproduced (Fig. 2) as they have never before been figured. The ooecia agree fairly with the description, but I could not see upon them the "fimbriated stigma," though there was on some of them an irregular line apparently marking the limit of a layer of tissue or thickening in the walls of the ooecia. The ooecia are on the upper surface of the zoaria, which is slightly convex, and near the periphery. In order to obtain a view of the ooecial openings which are situated at the base of the ooecia, it was necessary to tilt the slide so as to expose the edge of the zoarium to view. Scattered among the zooecia are some of the "semi-lunar slits" spoken of above. I have drawn a

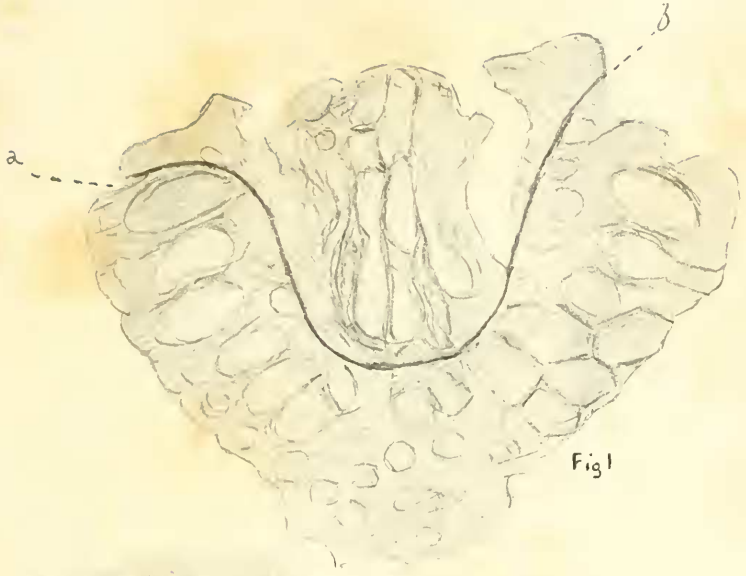
a
b
Fig 1


Fig 2a
a
Fig 2